The Afghanistan Engineering Support Program assembled this deliverable. It is an approved, official USAID document. Budget information contained herein is for illustrative purposes. All policy, personal, financial, and procurement sensitive information has been removed. Additional information on the report can be obtained from Firouz Rooyani, Tetra Tech Sr. VP International Operations, (703) 387-2151.

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MEMORANDUM

To: [redacted], Head of Vertical Structures USAID

From: [redacted]

Re: **WO-A-0005**
Ghazi Boys High School Water Supply

Date: January 31, 2010 (Revised February 22, 2010)

Blocks 1 and 2 of Ghazi Boys High School (GBHS) in Karte Char are currently nearing the end of construction. The school will operate with 3 shifts of 4,000 students; totalling 12,000 students. Two blocks are currently under construction. Each block will consist of 72 classrooms. There will be approximately 48 students per classroom and 200 faculty. The bathrooms are stacked in one corner of the blocks. There are no other facilities with water/sewer connections in the blocks. Another building for administration and labs is planned. The occupancy for the administration building is projected to be approximately 1,000 people however; these projections are yet to be confirmed. The blocks and administration building will be connected by a link way.

United Nations Office for Project Services (UNOPS) designed the buildings and a Turkish contractor, EDE, is performing the construction. The water supply design for the interior of the building is complete but not the exterior. This design was separated from the UNOPS design and construction scope. USAID has requested Tetra Tech review options for water storage and distribution.

On January 13, 2010 TetraTech attended a site visit to the GBHS at the request of Jeff Hepler, USAID- OIEE, Head of Vertical Structures. Subsequent to the site visit we met with Jeff and International Relief and Development (IRD) representatives to obtain more information about the school and the planned infrastructure; water, sewer and electrical supply and distribution. A portion of the UNOPS plans related to the classroom buildings and these systems were provided to TetraTech for our review. TetraTech additionally met with Ministry of Infrastructure (MOE) Infrastructure Department on January 20, 2010 to discuss current practices in Afghanistan at other educational facilities.

This memo summarizes our observations and findings related to water supply and site distribution:

Existing Water Supply

According to maps reviewed by TetraTech as part of the Kabul Water Supply System USAID Work order and further discussions, water supply lines in the vicinity of the Ghazi Boys High School (GBHS) are not currently sufficient to provide the quantity and quality of the water required to serve the school. Additional system infrastructure (distribution lines, water storage, pump stations, etc) is proposed for the immediate area through the *"Extension of the Kabul Water Supply System" Medium Term Program ("MTP")* however financing for the program is yet to be negotiated. A meeting with Dad. Mohammad Baheer from the Afghan Urban Water Supply and Sewerage Cooperation also confirmed this information.

It is our understanding the current October 20, 2009 GBHS plans show the water management plan as initially proposed by UNOPS. The plan is to drill a deep tube well and construct two elevated water storage towers. Well water is to be pumped directly to the water towers. Hydrogeological information for the well was not provided for our review as UNOPS is performing the well design.

Projected Water Demand

Blocks 1 and 2 are currently under construction at GBHS. Each block consists of 72 classrooms and 3 bathrooms on each floor. The total population of the school for the three buildings proposed is 12,000 students in three shifts which are scheduled from 8am to 5pm. Each shift is 2.5 hours long with 4,000 rotating students and 200 faculty. The projected student population and projected demand is shown in Table 1. US design standards range between 20 and 40 lpd/student depending on the type of school and its facilities. Design ranges were compared with US, India and Afghanistan standards (as discussed with the MOE) for similar educational facilities. Administration and Lab facility usage were generally considered with USAID concurrence using assumed cultural standards. The projected water demand of 30 lpd/student and faculty has been calculated using assumed and agreed upon demands based on discussions with USAID.

TABLE 1

UNIT	Amount	l/ppd	Total - l/pd
Students	4,000[2]	30[1]	120,000
Faculty[3]	200	30	6,000
		TOTAL	***126,000 (88 l/min)***
		Assumed[5]	***120,000 (83 l/min)***

(1) US Day schools = 35-75 l/ppd with cafeterias
(2) Assumes 3 shifts of 4,000 students + faculty 8am to 5pm occupancy
(3) 200 faculty assumed for the day
(4) Administration & labs are to be in future Block
(5) Based on USAID guidance

Water Storage

Water storage should be provided to meet peak demands, to provide for fireflow requirements, to maintain relatively uniform water pressure and to eliminate the necessity for continuous pumping. (Daily peak demands and fireflows are not considered in this analysis)

Design assumptions for storage include:

- Block buildings were not considered to be sprinklered.
- Storage of 180 CM (6,360 CF) is calculated for one day (24hr) of usage plus fireflows. 2 to 3 day storage is preferred. Additional days of storage could be considered once well production is known.
- Available hydrogeological information needs to be a key factor of this water system design.
- Pumping facility design was not considered.

Two 90 CM storage towers (4-story with sufficient height for maintaining pressure) are recommended. This will provide a supply of water adequate for average day usages. These towers are to be interconnected as to be usable as standalone during emergencies. If an underground storage tank is selected, a large diameter shallow tank is preferred to a deep tank of the same capacity since it will be less expensive to construct and water pressure fluctuations will be reduced.

Three smaller 60 CM (2,119 CF) interconnected tanks is an alternative approach to be located adjacent to each Block: topography dependent.

Storage options:

We evaluated the following storage options.

1. Direct pumping to the building system
2. Hydro-pneumatic Tank and Pump System
3. Underground tank and small elevated tank on top of building
4. Elevated water Tank/Tower

Direct pumping to the building system

Pumping from an underground tank directly to the bathroom fixtures would require a reliable pump, power source and a backup generator. A pump would be required to continuously operate to provide the needed water. This would require a pump of high quality yet one that could be operated efficiently. If this option is to be considered, the system design should include a cost benefit analysis for the costs of purchase, maintenance and operation of the water system and the backup generator.

Without the alternative power source (generator), once power was disrupted, no water would be available. To compensate for power outages, water storage for not less than one-half the total daily consumption is recommended. The preferred storage capacity is the maximum day usage plus fire requirements.

Of the alternatives considered, this is the least preferred alternative.

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Hydro-pneumatic Tank and Pump System

Rather than pumping to the bathroom fixtures, pumping from the underground tank to a series of 4-8,000 liter hydro-pneumatic tanks prior to distributing water to the individual blocks is an option that may be more reliable. The pump transfer system would consist of one jockey pump at 800 l/m, two(2) normal operating pumps at 900 l/m and one backup pump at 900 l/m. The hydro-pneumatic tanks would include 3-8,000 liter bladder tanks; all interconnected. The hydro-pneumatic system provides less wear on the pump control system and a more uniform flow that minimizes water hammer.

Underground tank and small elevated tank on top of building

The use of an underground tank combined with a smaller tank on top of each building could supplement the previously described direct pumping system. Elevated storage is provided within the distribution system will help to equalize system pressures. Since the direct pumping system would be unreliable due to power outages, this tank could supplement the supply for a 24-hour function and even out pressure fluctuations.

This system would be more complicated mechanically with well pumps + smaller distribution pumps. Automation could be considered to minimize maintenance requirements however; system operation would be more sophisticated requiring more training.

Elevated water Tank/Tower:

Elevated storage should be provided within the distribution system to supply peak demand rates and equalize system pressures. In general, elevated storage is more effective and economical than ground storage because of the reduced pumping requirements. The storage can also serve as a source of emergency supply since system pressure requirements can still be met temporarily when pumps are out of service. A structural design is required.

Well pumps with higher capacity can be used so pumping will only occur for relatively short periods of time to fill the tank. Once filled, the system can function for certain periods of time (depending on the designed storage capacity) when the utility and backup power is disrupted. Distribution main pressure will be determined by the elevation of the tank. This system has the fewest mechanical components and the majority of its components are regulated by gravity force.

Elevated storage can be above natural grade supported by a tower or pedestal where all storage is contained above ground. (Feeder and supply lines would be underground), at natural grade or below natural grade. Storage below natural grade is usually done for aesthetic reasons although water towers can and have been designed to compliment site use. Storage at natural grade is preferred where local terrain will allow the placement of a tank (such as on a hillside) sufficiently above the facility to be served. Storage above natural grade is used when the terrain is flat or when gravity-fed storage at natural grade would be impractical which is the case with the GBHS site.

Conclusion:

Tetra Tech recommends that an elevated above ground tank or tower be designed and built to serve the needs of the GBHS.

- The total water storage requirements for the GBHS site are estimated at 180,000 l/d (47,550 gal/d) requiring a 180 CM (6,360 CF) storage facility.
- Elevated tanks or towers (2 towers at 4 stories) would be the preferred option.
- Each elevated tower recommended for the GBHS will need to be designed to supply pressures between 30-45psi.
- A structural design will be required.
- High capacity well pumps should be used so that the tanks can be filled in a relatively short period of time. Direct pumping from the well to the towers is envisioned.
- The system would be able to function without power for a short period of time without power during power disruptions.
- Maintenance will be minimized since mechanical components are reduced and the majority of the system would be by gravity force.